

The Mining Journal

AND COMMERCIAL GAZETTE.

SUPPLEMENT.

PROCEEDINGS OF SCIENTIFIC MEETINGS.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

[Concluded from page 11.]

Passing over Section D (Zoology and Botany) and Section E (Anatomy and Medicine), as unconnected with the objects of our publication, however interesting and important in themselves, we arrive at Section F, Statistics, from which we shall now proceed to make some extracts. The first communication brought before the Section was by Dr. Cleland, and although modestly termed "A Few Statistical Facts, descriptive of the Former and Present State of Glasgow," may be considered as one of the most valuable, comprehensive, and interesting contributions ever made to statistical science. The statements we now quote strikingly illustrate the rapid commercial progress of this flourishing town within the last half century.

TRADE.—The increase of trade at Glasgow, in consequence of the improvements on the river, almost exceeds belief. Less than fifty years ago, a few gabbarts, and these only about thirty or forty tons burden, could come up to Glasgow. The recent improvements have been such, that in the year 1831, vessels drawing thirteen feet six inches water, were enabled to come up to the harbour; and now large vessels, many of them upwards of 300 tons burthen, from America, the East and West Indies, and the continent of Europe, as well as coasters, are often to be found three deep along nearly the whole length of the harbour. During the year 1834, about 27,000 vessels passed Renfrew ferry; and at some periods of the year, between twenty and thirty in one hour. A few years ago the harbour was only 730 feet long on one side; whereas it is now 3340 feet long on the north side of the river, and 1260 on the south. Till of late years there were only a few punts and ploughs for the purpose of dredging the river; now there are four dredging machines, with powerful steam apparatus, and two diving-bells. Till 1834, the river and harbour dues were annually disposed of by public sale, but now they are collected by the trustees, consisting of the members of the Town Council, and five merchants appointed by them.

AMOUNT OF REVENUE, EXPENDITURE, AND DEBT.

Date.	Revenue.	Expenditure.	Debt.
From 1752 to 1770	£ 147 0 10	£ 2680 4 11	£ 2533 4 1
1835	31,910 19 3	29,609 13 11	124,003 13 9

It appears from the evidence of Mr. James Russell, harbour-master for the department of steam-vessels, before a Committee of the House of Commons, in May, 1836, that there were seventy-five steamers plying to and from Glasgow, tonnage 688,568, and that during 1835 there were 8401 arrivals of steamers, twenty of them of the largest class, and some of these about 200 feet long (equal in length to frigates of the first class).

AMOUNT OF CUSTOMS' DUTIES COLLECTED AT GLASGOW, IN YEARS ENDING 5TH JANUARY.

Year.	Duties.	Year.	Duties.
1812.....	£ 3124 2 4	1825.....	£ 41,154 6 7
1813.....	7511 6 54	1826.....	78,938 13 8
1814.....	7419 12 84	1827.....	71,922 8 0
1815.....	8300 4 34	1828.....	74,255 0 14
1816.....	8422 9 23	1829.....	70,964 8 4
1817.....	8290 18 1	1830.....	59,013 17 3
1818.....	6802 1 3	1831.....	72,053 17 4
1819.....	8384 3 4	1832.....	68,741 5 9
1820.....	11,000 6 9	1833.....	97,041 11 11
1821.....	11,428 19 0	1834.....	166,913 3 3
1822.....	16,147 17 7	1835.....	270,667 8 9
1823.....	22,728 17 24	1836.....	314,701 10 8
1824.....	29,226 15 0		

It is probable, from present appearances, that the duties for 1837 will amount to 400,000l.

STEAM-VESSELS.—The whole race of steam-propelling projectors having left the field one by one, without being able to effect the object of their ambition, the ground was occupied by Mr. Henry Bell, who was bred a house-carpenter. Having a turn for mechanics, and a great desire to follow out what others had abandoned, he employed Messrs. John Wood and Co., of Port Glasgow, to build a boat for him, which he called the *Comet*, and having himself made a steam-engine of three-horse power, he applied the paddles. After several experiments, the *Comet* plied from Glasgow to Greenock, on the 18th January, 1812, and made five miles an hour against a head wind, while, in a short time, by simply increasing her power, she went seven miles an hour. This was the first vessel that was successfully propelled on a navigable river in Europe; and it is very remarkable, that notwithstanding the great progress in mechanical science, no improvement has yet been made on Mr. Bell's principle, although numerous efforts have been made, here and elsewhere, for that purpose. It is true, that boats go swifter now than formerly, but the propelling system remains the same.—All the new boats, either for the out-sea or river trade, are of greater engine power, and are much more splendidly fitted up for the accommodation of passengers. The speed is also greatly improved. The Liverpool steam-boats, in 1831, were thought to have made good passages, when they performed the run from Liverpool to Greenock, a distance of 220 miles, in twenty-four to twenty-six hours. It is now done much sooner. On Wednesday, 24th June, 1835, the *City of Glasgow* steam-boat left Greenock, and arrived in Liverpool in the unprecedented short period of seventeen hours and fifty-five minutes; and the steam-boat *Manchester* left the Clarence Dock, Liverpool, on Monday evening the 15th December, 1834, and arrived in Glasgow, a distance of 240 miles, discharged and loaded her cargoes, and was back again in the same dock, within the short period of sixty hours.

The cabin fares of the river boats are rather less than one penny per mile, and those of the out-sea packets rather more. The fare from Glasgow to Liverpool is 11. 5s.

INTERCOURSE WITH GLASGOW.—Dr. Cleland has published the names and destinations of 61 stage-coaches, which arrived and departed during 313 lawful days, each averaging 12 passengers. This gave 458,232 persons in the year. By 37 steam-coaches, 25 passengers each, 579,050; by the swift boats on the Forth and Clyde Navigation and Union Canal, 91,976; by the light iron boats on the Paisley Canal, 307,275; by the boats on the Monkland Canal, 31,784; and by the Glasgow and Garmark railway, 118,182. These together make the gross number of persons passing and repassing to Glasgow daily amount to 1,587,198.

The following account of early stage-coach travelling is too curious to be passed over:—

STAGE-COACHES.—Stage-coaches were first introduced into Scotland in 1678. On the 6th August, in that year, Provost Campbell and the other magistrates of Glasgow contracted with William Hume, of Edinburgh, that he should run a coach between Edinburgh and Glasgow, a distance of forty-two miles. The following is an abstract of the indenture, which is rather curious. Hume engaged with all diligence to run a coach with six able horses, to leave Edinburgh every Monday morning, and return (God willing) every Saturday night; the passengers to have the liberty of taking a cloak-bag for their clothes; the *burghesses of Glasgow* to have a preference to the coach; the fare from the 1st March to the 1st September to be 4l. 16s. Scots (no sterling); and during the other months, 5l. 8s. Scots. As the undertaking was arduous, and could not be gone into without assistance, the magistrates agreed to give Hume 200 merks a-year for five years. The coach was to run for that period whether passengers applied or not, in consideration of his having actually received *two years' premium in advance*, 22l. 4s. 5½d. sterling.

Dr. Cleland has obtained the following curious information from Mr. Dugald Bannatyne's scrap-book:—

The public have been so long familiarized with stage-coach accommodation, that they are led to think of it as having always existed. It is, however, even in England, of comparatively recent date. The late Mr. Andrew Thompson, sen., informed me that he and the late Mr. John Glassford went to London in the year 1739, and made the journey on horseback. That there was no turnpike-road till they came to Grantham, within one hundred and ten miles of London. That up to that point they travelled upon a narrow causeway, with an unmade soft road upon each side of it. That they met from time to time strings of pack-horses, from thirty to forty in a gang, by which goods seemed to have been transported from one part of the country to another. The leading horse of the gang carried a bell, to give warning to travellers coming in the opposite direction; and when they met these trains of horses, with their packs across their backs, the causeway not affording room to pass, they were obliged to make way for them, and plunge into the side road, out of which they sometimes found it difficult to get back again up the causeway.

The following statistical notices are interesting, and some of the information conveyed is very curious:—

STEAM-ENGINES.—There are in Glasgow and its suburbs 310 steam-engines, viz. 176 employed in manufactories; 59 in collieries; 7 in stone-quarries; and 68 in steam-boats. Average power of engines, 20.46-100th; total horses' power, 6406.

COALS.—In 1831 the quantity sent to Glasgow amounted to 361,049 tons, of which 124,000 were exported, leaving for the use of families and public works 437,049 tons.

AVERAGE PRICE OF COALS DELIVERED IN QUANTITIES IN GLASGOW DURING ELEVEN YEARS.

In	Per Ton.	In	Per Ton.
1821.....	8 4 to 9 4	1827.....	6 3 to 7 3
1822.....	7 11 to 8 11	1828.....	5 10 to 6 10
1823.....	7 6 to 8 6	1829.....	5 10 to 6 10
1824.....	7 11 to 8 11	1830.....	5 10 to 6 10
1825.....	11 1 to 12 1	1831.....	6 10 to 7 10
1826.....	9 7 to 10 7		

Previous to the year 1755, all colliers and other persons employed in coal-works were, by the common law of Scotland, in a state of slavery. They, and their wives and children, if they had assisted for a certain period at a coal-work, became the property of the coal-masters, and were transferable with the coal-work, in the same manner as the slaves on a West Indian estate.

TIMBER TRADE.—Messrs. Pollock, Gilmour, and Co., who are chiefly engaged in the North America timber trade, have eight different establishments, that ship annually upwards of six millions cubic feet of timber, to cut and collect which, and to prepare it for shipment, requires upwards of *fifteen thousand men, and six hundred horses and oxen* in constant employment; and, for the accommodation of their trade, they are owners of twenty-one large ships, the registered tonnage of which is twelve thousand and five tons, navigated by five hundred and two seamen, carrying each trip upwards of twenty thousand tons of timber, at forty cubic feet per ton; all of which ships make two, and several of them three, voyages annually. It may be truly said that this establishment is unequalled in Europe.

IRON WORKS IN SCOTLAND IN JUNE, 1836.

Erected in or about the year	Furnaces.	Tons.
1767, Carron Company.....	5	8000
1786, Clyde.....	4	12,000
1786, Wilsontown.....	1	3000
1790, Muirkirk.....	3	6000
1790, Cleland.....	1	2500
1790, Devon.....	3	7000
1805, Calder.....	5	15,000
1805, Shotts.....	1	3000
1825, Monkland.....	3	8000
1828, Gartsherrie.....	5	15,000
1834, Dundyvan.....	4	12,000
Total.....	35	92,000

Exclusive of the above furnaces, there are eight additional ones in a state of forwardness, viz. two at Gartsherrie, one at Calder, one at Monkland, two at Somerlie, and two at Govan. These eight furnaces will make about 20,000 tons annually.

These works are all in the neighbourhood of Glasgow, excepting five, and none of them are thirty miles distant from that city.

ST. ROLOX CHEMICAL WORKS.—These works for the manufacture of sulphuric acid, chloride of lime, soda, and soap, the most extensive of any of the kind in Europe, cover ten acres of ground, and within their walls there are buildings which cover 27,340 square yards of ground. In the premises there are upwards of 100 furnaces, retorts, or fire-places, and in one apartment there are platina vessels to the value of upwards of 8000l. In this great concern, upwards of 600 tons of coal are consumed weekly.

The following communication was made by Dr. Lardner "On the Statistical Results of Railway Communications," a subject for which it was the opinion of many gentlemen present, we are yet hardly in possession of sufficient data:—

The subject was one which, at the present time, was particularly interesting; but it was not for the purpose of showing how far railway speculations, as such, might become profitable, that he should bring them forward—he had a higher object, which was that of endeavouring to ascertain, and if possible, to establish the general law which governed the increase of inter-communication which they led to. He was not prepared to lay before them any particular results, as to the general effects of railways; he should confine himself to a few facts which seemed to shadow forth the probability of a statistical law in reference to the point to which he had alluded. When the Liverpool and Manchester railroad was projected, it was designed for the transit of goods only, at the rate of ten miles per hour; but it was unexpectedly found that treble speed was attainable, and then passengers became the primary consideration. Previous to the establishment of the railway, there were twenty-six coaches between Liverpool and Manchester, and the number of passengers making one trip was about 400 per day. Immediately on the establishment of the railway, that number rose to 1200; thus, in the very outset, an increase took place in the proportion of three to one. The railway had been in operation, he believed, since 1825, and from that period the number of passengers had gone on increasing, with the exception of the period of the cholera, which might very fairly be omitted in his calculations, and now the number was 1500 per day, being a further increase of one in four; and thus it appears that no less than half a million travel by it annually. Now, the population of Liverpool was 165,000, and that of Manchester 183,000, making a total of 348,000; and thus they would see that, out of those populations, an intercourse of more than half a million took place annually. The time by the fastest coaches was three hours; the time on the first opening of the railway was, by the fastest trains, one hour and a half; now it was but an hour and twenty minutes. The fare of the coaches was, outside, half-a-guinea—what it was inside he could not then recollect; by the railway, the average fare was 4s. 6d. In this instance diminution of time and expense both combined to increase the number of passengers; and the increase, it should be borne in mind, was exactly fourfold. The second example he should refer to, was the railway between Newcastle and Hexham; before the establishment of which, the number of passengers by coach monthly was 1700; it is now by railway 7000, being rather more than a four-fold increase. Now, the village of Hexham was by no means an important place; on the contrary, it was so insignificant that the wonder was, what could possibly require 7000 persons to go upon the railway. His third instance would be the Dublin and Kingstown railway. The city of Dublin contained 200,000 inhabitants, and Kingstown, which was distant about six miles, contained 6000 or 7000. There were no manufactories, no trade there; true, there was a harbour, but it was used exclusively by the Post Office packets; none of the commercial vessels—not even those who might be driven in by stress of weather—being permitted to discharge their cargoes; consequently no goods were carried on this railway. Now, when he stated what was the intercourse actually existing, under these circumstances, it must be admitted that the effect exercised upon it by the packets was very insignificant. The intercourse previously existing, too, it must be borne in mind, was carried on by means of a rude vehicle called an Irish car, and in this manner they were carried at prices varying from 5d. to 7d., the proximate number being about 800 daily. The railway had been opened about two years, and the intercourse was in the ratio of a quarter of a million of persons annually. Now that furnished another example of the numerical proportion previously referred to: for if they took the number of passengers before the opening of the railway at 800 daily, it would be found that the proportion of four to one would give 3200, and 3300 was the average of the present number—the travelling on the Sunday being 7000, the proportion the other days less; but the average above given being fully made up. He had thus shown that the law of increase was fourfold; he would now show that it depended infinitely more on the saving of time than money. On the Liverpool and Manchester railway the price was less than one-half the charge by the coaches; but on the Dublin and Kingstown railway the charge of conveyance was absolutely raised, and, besides that, the railway did not reach the latter place by half a mile, which occasioned to many an additional charge for carriage-hire to take them over the remaining ground. On that railway there were three classes of trains, and the fares were 1s., 8d., and 6d.; the carriages most filled being those at 8d.; it was quite fair, therefore, to assume that, in this instance, three out of every four travelling on the railway did so merely on the score of the saving of time. It would be well if they could go back and see what were the effects produced on intercourse by the establishment of turnpike-roads and the introduction of coaches; they would find probably that the great increase had been wholly owing to the time saved by the improvements effected. It

was remarkable, however, how much results varied, for he had ascertained that, though much improvement had of late years been effected in the mode of travelling by canals—in certain cases the boats having attained to a speed of ten miles per hour, equal to that of the coaches, while they carried their passengers at a far cheaper rate—yet he did not find that they added much to the intercourse. He alluded more particularly to the boats on the Kendal and Preston and the Edinburgh and Glasgow canals; and, he asked, could it be doubted, if railways were running parallel with them, that an increased traffic would immediately take place? He mentioned this merely to show how much more economy of time was regarded than the mere saving of money. Dr. Lardner then proceeded to remark on the value to new companies of the experience gained in working the Liverpool and Manchester railway. The charge for transport of passengers on the Manchester railway was 1.84-100ths of a penny per mile, the actual cost to the proprietors about 1d. per mile: whereas a Birmingham manufacturer had entered into a contract, by which the whole of the passengers on that line would be conveyed at the cost of one farthing a mile, including every expense of locomotive power, the company merely finding the carriages and the road. The same company had also formed a contract for the conveying of goods at 1d. per ton per mile, the contractor, as in the former case, defraying every charge for engines, &c. Dr. Lardner then proceeded to show the possibility of attaining so high a rate of speed as fifty miles per hour, and dwelt at great length on the effects likely to result to the general commerce of the country.

A paper was read by Mr. John Taylor, the Treasurer of the Association, "On the Comparative Value of the Mineral Productions of Great Britain and the rest of Europe." It appeared that this paper was founded on the calculations of M. C. F. Smidt, who had some years ago drawn up a table exhibiting the amount and value of the mineral produce of the various countries of Europe. These calculations were of course founded on continental prices, and would not therefore exactly agree with similar ones made in this country. They had been examined by Mr. Taylor, and appeared to be so accurate generally, that he had not hesitated to adopt them. The annual value of the mineral productions of Europe, including Asiatic Russia, were stated by Mr. Taylor as follows:—

Gold and silver.....	£ 1,943,000
Other metals.....	28,518,000
Salts.....	7,640,000
Combustibles.....	18,050,000

Making in round numbers a total of about 56 millions, exclusive of manganese.

It appears that Great Britain contributes considerably more than one-half of this vast amount of mineral produce, her mineral production being stated at twenty-nine millions, in the following proportions:—

Silver.....	£ 28,500
Copper.....	1,369,000
Lead.....	760,000
Iron.....	11,292,000
Tin.....	536,000
Salts.....	736,250
Vitriol.....	33,000
Alum.....	33,000
Coal.....	13,900,000

These statistical details were followed by a sketch of the progress of mining in this country, tracing more especially the important influence of the steam-engine, in stimulating and facilitating mining operations. The same subjects were touched upon at considerable length by Mr. Taylor in his address to the "Society of Arts" in the early part of the present year, of which a very full report is given in the *Mining Review*, No. 8.

Many interesting communications were made to this Section on Education and other subjects, but which do not seem to require notice here.

We now proceed to Section G, Mechanical Science, which although the youngest branch of the Association, is by no means the least important. Previous to the present meeting, the subjects belonging to this Section had been considered by the Mathematical and Physical department, an arrangement which was not however found convenient, and the Section of Mechanical Science was therefore instituted, in order that full justice might be done to the very important subjects included under this denomination.

The business of the Section was commenced by Professor Moseley, who offered some observations "On the Theory of Locomotive Carriages."

It was the object of these remarks, to establish the importance of causing to enter into the discussion of the theory of locomotion on railroads, the friction of the machinery of the locomotive carriage itself. This friction, the Professor stated, to be composed of two elements—one of which he termed the passive resistance of the machinery, being that which would oppose itself to a force applied to turn the wheels of the locomotive carriage if it were lifted from the railroad. This friction he stated to amount, in some cases, to 120lbs., and in others, to 170 or 180lbs., in the carriages employed on the Manchester railroad.

Besides this passive resistance of the engine itself, independent as it is of the load, the elevation of railroad, the velocity, or any other cause which affects the other conditions of locomotion, the Professor stated that there was a second element of the friction of the machinery, which was dependent upon, and proportional to, the load, inasmuch as it was dependent upon, and proportional to, the traction, which, in its turn, was dependent upon, and proportional to, the load. The friction of the machinery being thus composed of two elements, one constant, and the other proportional to the load, the Professor stated that the third element of resistance was the traction itself, being the friction of the train. The resistance being transferred, and operating upon one side of the piston, that which overcame it on the other side was the pressure of the steam, which, supposing the vaporizing power of the engine to be constant, varied inversely as the velocity. Moreover, when the machine had acquired its constant velocity, he stated that these two pressures must have become equal. These results and reasonings he stated not to be new, but not to be generally known: for the application of them to the theory of inclined planes, which followed, he claimed entire novelty. If (said the Professor) a locomotive carriage be made, with its train, to ascend an inclined plane, the following modifications will be made in the resistance to the motion of the machine and train. The passive friction of the machine will remain unchanged—the friction resulting from the traction will increase in the proportion in which the traction is increased—the traction will be increased by the resolved portion of the gravity in the direction of the plane, and it will be diminished, in so far as the friction of the train is concerned, in a ratio proportional to the cosine of the elevation. This diminution of friction of the train, he stated, nevertheless, to be counterbalanced by the increased distance through which the whole mass is moved; so that, on the whole, its effect was the same as though the whole had traversed a horizontal plane; so that, on the whole, the traction of the train arising from friction, and the friction of the machinery resulting from this cause, remained unaffected by the ascent. Again, the increased traction from gravity in ascent, he stated to be compensated by the diminished traction in descent, or, if the angle be greater than that of repose, by the actual acceleration in descent. But there remains, said the Professor, another element to be considered—namely, the friction of the machinery which results from the increased traction produced by gravity in the ascent. This he stated to have no compensation in the descent; by the ascent of the carriage the traction upon it might be increased double, the friction of its machinery would then be doubled; but, by the descent, the carriage and its train being equally accelerated, the friction resulting from traction would, indeed, be reduced to nothing, but it could assume no negative form compensating the friction of the machinery in the ascent: so that, on the whole, there was lost the whole increased friction of the machinery in the ascent, compensated by no corresponding diminution in the descent. These remarks the Professor stated to apply exclusively to the case of inclined planes having an elevation greater than the angle of repose. The loss of power in this case he stated to be considerable, amounting, perhaps, to one-fifth of the traction, and, since an inclined plane will not infrequently double or triple the traction, amounting in the whole to a considerable fraction of the force expended and the coal consumed. The great loss of power thus resulting from the increased friction of the machinery in an ascent not compensated in the subsequent descent, the Professor stated to be an element neglected in the computations usually made on the expense of different lines of railroad.

Dr. Lardner stated his entire concurrence in all that had fallen from Professor Moseley, and then proceeded to enter upon the discussion of a variety of facts of great interest and importance connected with the theory of railroads, to which, having had his attention of late called by frequent examinations before committees of parliament, he had devoted much time. The traction resulting from friction on a horizontal plane, he stated to have been

estimated differently by different engineers, at from 11bs. to 11lbs. per ton; from some experiments of his own, made with much care, he concluded it to be about 7½lbs., by which sum the traction was increased by each additional ton of loading. He alluded to a variety of circumstances by which this friction may be modified, and mentioned, in particular, the effect which wetting the rail appeared to have upon it—the carriages, after a shower of rain, travelling with much greater speed and facility than before it; and he suggested that watering-pots might, with great advantage, be placed before a train of carriages, watering the rail continually for the wheels which were to follow it. The condition of the rail opposite to this, of its greatest freedom from friction, was that in which it was covered with particles of earth, triturated stone, or dust; to try the effect of this condition of the rail, he had strewn sand on the surface of the rail, where it had an inclination above the angle of repose, and had found the friction in this sand sufficient to counteract the tendency of the train to descend by its gravity. It having appeared, from some of Dr. Lardner's remarks, that he considered the loss of force produced by the working of a carriage over an inclined plane to result from the necessity of applying the brake when the angle is greater than that of repose, and from no other theoretical cause, although practically there was a sacrifice in working of the engine by reason of the superfluous steam thrown off in the descent, Professor Moseley inquired, whether, in the event of the steam thus lost being by some means harnessed from the period when the train commenced its descent, and the brake not put on, he would consider any force to be lost in the whole transit of the carriage over the incline. The Doctor having declared that to be his view of the matter, Professor Moseley stated that he had not then understood the bearing of his remarks, or did not agree in them. The resistance to the motion of the carriage, he again stated to be composed of a constant element, and an element varying in every case with the traction;—the constant element in working an incline, to be worked round the two sides of a triangle instead of the one side, which it would traverse if there were no incline;—and the other element varying with the traction, and dependent upon the friction of the machinery of the engine, to be greatly increased in the ascent of the plane, and to be evanescent in the descent; thus presenting itself in the descent in no negative form, under which it might compensate the loss in the ascent. The Section having been addressed by two of its members, whose names were unknown to us, one of whom stated the method of watering the rails to have been adopted with success on some of the tram-roads in Wales, the President rose, and shortly went over the arguments which had been used, and pointed out some of their practical relations,—mistaking, however, as it appears to us, a remark which had been made that the effect of the friction of the train, as distinguished from the engine, would, on the whole, be the same, whatever be the inclination of the plane; this assertion (made by Professor Moseley) he questioned, not, it appears to us, having paid attention to the Professor's explanation, that this friction, varying in amount, as the co-sine of the inclination, and its whole effect being estimated by its amount, multiplied by the distance through which it operates, that product must, both in the ascent and the descent, vary as the product of the length of the plane by the co-sine of the inclination; that is, it must vary as the horizontal base of the plane, and be the same though the carriage were worked along that base instead of up the plane.

The following valuable communication was made by Mr. Russell, of Edinburgh, detailing the practical results of his experiments on the resistance of vessels moving with different velocities on canals, a paper to which we have previously had occasion to allude:—

On the general principle, of the resistance of fluids to bodies moving in them, was grounded the conclusion, that it would be an impracticable thing to move the cumbersome boats upon canals at any but very low velocities, except by an expenditure of power so great, that the ordinary methods of conveyance by roads would be cheaper. It was believed, that the resistance would increase with the velocity, by a law so rapid in its variation, that for two miles an hour speed, there would be four times the resistance of one mile; for three miles, nine times that of one mile; for four, sixteen times; and so on, as the squares of the velocities. Here there was an obstacle to rapid communication by canals, which appeared insuperable. Mr. Russell has shown that there is practically a circumstance which so completely modifies the application of this principle, that when over a certain point of speed is attained, the resistance, instead of increasing, when the speed is yet further increased, in point of fact diminishes. In one of his experiments, he found, for instance, that the resistance to the traction of a canal-boat, estimated by a dynamometer, increased with the velocity of its motion nearly according to the law of the squares, up to seven and a half miles per hour, being then 330lb.; the speed being then increased to eight and a half miles per hour, instead of further increasing the resistance, fell to 210lb. The speed was yet further increased, and it increased again the resistance to 236lb.; yet, less, be it observed, than at seven and a half miles; twelve miles an hour brought it to 352lb., scarcely more than the resistance of seven and a half miles speed.

These results, confirmed by a number of others, had manifestly a practical application, and they have been applied to the working of fast canal boats in Scotland. Mr. Russell has devoted himself to the explanation of them. He states, that where the water of a canal is disturbed by any cause, as, for instance, the admission of a rush of water momentarily into one extremity of it, or the impeding of a body moving in it, there is generated a certain wave, whose motion along the canal is altogether independent of the nature or velocity of the impulse given to it, and dependent only upon the depth of the canal; its velocity being precisely that which a stone would acquire in falling down one-half the depth of the canal. With this velocity, the wave moves uniformly and steadily to the very end of its motion, moving slower (if the depth of the canal remain unchanged), but only diminishes its dimensions, until it disappears, and this not for a very considerable space. He stated, that he had himself followed waves a mile and a half, and that they had been traced unbroken for three miles from the spot where they originated.

The velocity of the wave depending on the depth of the canal, it is manifest, that each canal, differing in depth from another, will have a different velocity of wave, and that each part of the canal differing from another will alter the velocity of its wave, and thus the waves near the sides will move slower than near the centre of the canal, if the side be shallower than the middle. How, then, have these facts their application to the phenomenon observed? Thus, in the experiment described above, the velocity of the wave, ascertained by numerous experiments, was eight miles an hour. As long, then, as the boat moved at three, four, five, six, or seven miles an hour, it remained in the rear of the wave; the wave had no effect on it, as the law of the velocities was the theoretical law. At eight miles an hour the boat was, in point of fact, on the wave, and it might, indeed, be seen about the centre of the boat lifting it out of the water, and diminishing the traction upon it.

Passing over many communications, to us of secondary interest, we come to one of the most valuable of the whole, being a paper by Mr. Enys. "On the Duty of Steam Engines in Cornwall," of which the following report will convey the principal facts:—

Mr. Enys stated some facts connected with the recent history of these engines, which are of the highest interest and importance. There are instances in which the work done by an engine has, by means of certain precautions with regard to the radiation of heat from the boiler, and a method of working the steam, as it is termed, *expansively*, been doubled with the same expense of coals.

It appears that when the engine of Mr. Watt was introduced in Cornwall, and that of Newcomen superseded the patentee fixed, as the remuneration for the use of his patent, that he should receive one-third of the profit which his engine would yield over one of the old construction, estimated by the value of the coals which would be saved by it in producing a given effect. The effect was to be estimated by the quantity of cubic feet of water which a bushel of coals would raise one foot high in one hour, called the duty of the engine. With engines of the old construction this was fixed at about seven millions, and an instrument being contrived by Mr. Watt for registering this duty on his engines, it was found to amount in 1793 to nineteen millions and a half; thus effecting a clear saving of considerably more than one-half the coals required to produce the same effect; the profit thus accruing was immense: in one instance, that of the Chasewater Mine, in Cornwall, Mr. Watt's third of this profit was compounded for at the rate of 24000l. annually. In 1798 the duty of Mr. Watt's engines had fallen, from some cause unexplained, to seventeen millions and a half; and after the expiration of his patent, less attention appears to have been paid to the duty of engines than before, when they were registered for the payment of the patentee, and the duty had fallen in 1812 to thirteen millions and a half. It has now been raised on an average in the Cornish engines to fifty millions, being an economy of fuel amounting to between four-fifths and five-sixths of the whole consumption in 1812. The means by which this wonderful economy of fuel has been produced have been, 1st. A more careful application of all the heat given off by the coals to the production of steam. 2ndly. A more effective application of the steam itself, when thus produced to the working of the engine. The first object is attained partly by casing the boiler with wood, a space being left between it and the boiler, in which sawdust is rammed—the case thus filled is an admirable non-conductor of heat—a vessel in which all the heat contained in the boiler is carefully preserved and employed in generating steam; so effectual, indeed, is this precaution, that in the engine-house, which used to be unbearably hot, the men have been known to require a fire to keep themselves warm. Another method of applying the heat more entirely to the generation of steam consists in an improved construction of the boiler, by which the heated air is brought in contact with a greater surface of water, or rather of metal, having on its other surface water; and last, but not least, by a more careful cleansing of the interior surface of the boiler from the hard deposit which forms upon it, and was formerly allowed to accumulate sometimes to the thickness of half an inch. These are the methods

by which the heat yielded by the coals has been more effectually applied to the production of steam.

The second and great improvement consists, however, in the more effective application of the steam after its production to the working of the engine, by working it *expansively*. The meaning of the term "working expansively" is this: the valve through which the steam is admitted would, if there were no expansive power in the steam, manifestly require to be kept open during the whole time that the piston, which it drives before it, was traversing the cylinder, and the instant it was shut off, the piston would cease to move. Steam, however, is an elastic fluid, and the steam at any time admitted into the cylinder, would, even if all communication with the reservoir from which it came were closed, still by its own expansive force tend to move the piston, and would actually move it if the resistance upon it were not in excess. Now the improvement of working expansively consists precisely in this expedient of shutting off the steam from its communication with the boiler before the course of the piston is completed, and leaving it to be impelled through the remainder by the expansive energy of the steam already admitted. Formerly the steam continued to be admitted until the course of the piston was completed; now it is shut off when the piston has traversed from one-sixth to one-half the whole length of the cylinder, and thence principally has resulted this enormous saving of fuel.

An engine at the Consolidated Mines was by these means got up (as an experiment) to a duty of 120 millions, thus producing with the same quantity of coals nearly nine times the useful effect of the engines commonly in use in 1812. In carrying these various precautions for the economy of fuel into effect, the agents are, of course, the engineers and the engine-men, stimulating them to bring about the results we have stated, the exciting cause has been the publication of "duty papers," copied from registers made daily of the "duty" of each engine; these are taken with scrupulous accuracy, and with the most certain precautions against deception; and thus a comparison may continually be drawn between the working of different engines, involving the character of the engineers, and even regulating their wages, for a certain allowance is commonly made by the masters for all duty done beyond a certain limit. The engineer is thus induced carefully to examine every part of his engine, to keep it in the best possible condition, to husband his coals most scrupulously, and to cherish the heat in his boiler by every conceivable expedient of sawdust, and flannel, and wood, and plaster. When the expedient of a sawdust coating was first introduced, it is said that all the sawdust to be obtained in the country was for the time exhausted.

Mr. Enys further mentioned an important improvement in the working of the engines used for stamping the ore in Cornwall. These were formerly double-stroke engines, and the rapid motion of the piston was reduced to that required for stamping, by the intervention of a train of cog-wheels. It was believed that the operation of stamping could not be carried on by a single-stroke engine, of which class of course are all those used in Cornwall for raising water. It was, however, conceived that it would be possible, by the use of large fly-wheels, and heavy connecting rods, to throw enough of momentum into the machinery to carry it through the descending stroke, and effect all the purposes required of it for stamping, and moreover to obtain a great increase of duty by the substitution of a single for a double action engine. One was constructed at Wheal Kitty, from which was obtained the enormous duty (for a stamping engine) of fifty-five millions, instead of a duty which ranged on the old construction from six and a half to twenty-three millions. A part of this effect is however to be attributed to having dispensed with the train of wheels used before for reducing the velocity, and their friction, and to having connected the stampers immediately with the crank (as we understood) of the engine. Mr. Enys concluded by proposing a new form of the Cornish duty paper, including the passive resistance or friction of the engine. The following are its principal elements:—

The Efficiency—Gross power, force, and space of steam cut off.
Power—Net power (independent of friction) available for impelling machinery.
Effect—Gross work done, including friction.
Duty—Real work done.

The next communication, which appeared to the inhabitants of Bristol to have been the most interesting of the whole, as bearing on their great project of Steam Navigation to America, was by Dr. Lardner. This gentleman treated the subject of Steam Navigation to distant countries with great ability, laying down many important facts with much clearness and precision. His observations on the subject are thus reported by the *Athenaeum*:—

Dr. Lardner then addressed to the Section a discussion of the important question of steam navigation to distant parts, and especially to America: a question at the present moment of great interest every where, and especially at Bristol, where a company of merchants is now building a steam-vessel of 1200 tons burden, to navigate directly between that port and New York.

He began by observing, that the very circumstance of the present and pressing interest which was felt upon the subject of steam communication with distant parts of the world—the fact that already considerable investment of capital had been made in such speculations—were circumstances which would somewhat embarrass them in arriving at a safe and certain conclusion, because it would be obvious that they would, more or less, engender in the minds of a considerable portion of prejudices which would be liable to bias their judgment. He was aware that since the question had arisen in this city it had been stated that his own opinion was adverse to it; that impression was totally wrong; but he did feel, that great caution should be used in the selection of the means of carrying it into effect. He believed that those who knew him would readily acquit him of being forward to question the power of steam. But there were distinctions to be drawn, depending on the length of the trips and on the stages into which they were divided. There was one main distinction between the operation of a marine engine and a land engine. The marine engine was used with salt water, and the land engine with fresh water. Heat would convert that water into steam; but the heat which would do that with the water would not do that with other subjects which were combined with sea water; it would not do that with salt, which in consequence produce an incrustation in the boiler, and this was most injurious. A remedy for this had been discovered which was almost perfectly efficient, which was the use of copper boilers. There had been a contrivance brought into operation, which, if it was as effectual as its promoters considered it to be, would be a perfect remedy—he alluded to a condenser, which was known by the name of Hall's condenser, which was so contrived that the steam circulated like the blood in the human frame; but this had been discovered by Watt, who had left little for his successors to do. With regard to the power of steam-engines, practical men considered that for short trips the best proportion was to give the vessel the power of one horse for every two tons: that as the length of the trips increased they must have a smaller proportion of power; there should be three tons for every horse power; and that for the longest trips to which steam power could at present be applied, the proportion should be at most one horse to four tons. It might be asked why this particular proportion was selected? and the answer was this—that it was found by experience that such would not contain sufficient coals; but the surplus of power in long voyages would be invaluable where power was most valuable. It was necessary they should devise some means of determining the locomotive duty of coals. He had made extensive observations, and he considered you must place 15lb. of coal per hour for every horse. Mr. Watt some time since established a series of experiments on boilers, with the view of determining the relative consumption of fuel, and the result was this—that the consumption of fuel under the marine boilers was one-third less than under the land boilers. Dr. Lardner then recapitulated the evidence collected by a Committee of the House of Commons on the expediency and practicability of a long steam communication with India; he instanced, also, the line of steamers from Falmouth to Corfu, touching at Gibraltar, which, on an average of fifty-one voyages, made their trips at the rate of seven miles and a quarter per hour. Almost all the vessels with which the experiments had been made had the patent paddle-wheels, and they had been worked with the best coals. The next question was, what modification the vessel must undergo when applied to steam communication with the United States. In the Atlantic there were westerly winds which prevailed almost continually, and were extremely violent, and attended with a great swell of the sea; but it was an astronomical phenomenon which was very well understood. The outward voyage of the great packet ships was generally estimated at forty days, the homeward voyage at twenty days, so that the entire voyage occupied sixty days. If, then, they assumed that the average of the outward and homeward voyage to the United States corresponded with the average weather between Falmouth and Corfu, then they would arrive at this conclusion, that the outward voyage was worse than the average in the proportion of four to three. Taking his data from the voyage between Falmouth and Corfu, Dr. Lardner entered into some calculations with respect to the quantity of coal which would be required on the direct line from Bristol to New York. The result of these led him to conclude that it would be inexpedient to attempt a direct voyage. The question, then, he said, became a geographical one, as to the best mode of accomplishing the voyage. There were two ways which might be proposed; one to make the Azores an intermediate station, and to proceed from thence to New York; the other would be to proceed to some point in Newfoundland, and make that an intermediate station. The distance from Bristol to the Azores was 1300 miles, and from the Azores to New York 2400 miles. There was a point called Sydney, in Cape Breton, where there were coal-mines, worked to a profit by Messrs. Russell and Bridge, but then that was 2300 miles; but if we took our final departure from some place upon the western coast of Ireland, and there charged the vessel with coals,

the distance to Sydney would be only 1900 miles. He would therefore counsel those who proposed to invest capital in this most interesting enterprise to keep in mind certain points to which he should direct their attention. 1st. He would advise that the measured tonnage should correspond with the tonnage by displacement. 2nd. To go to an increased expense in using the best coals. 3rd. He would earnestly impress upon them the expediency of adopting the paddle-wheels shown in the Section yesterday. 4th. He advised the proportion of one to four on the proper tonnage. 5th. He would impress upon them the expediency of giving more attention to the selection of engineers and stokers; it was a matter of the last importance, as a saving of thirty to forty per cent. might result. With respect to the boilers, he would recommend copper ones. Lastly, he would advise the coal-boxes to be tanked.

A supplementary meeting of the Mechanical Section of the Association was held on Saturday morning, at which Dr. Lardner resumed his reply to those who spoke on Thursday, on the subject of Steam Communication with the United States.

He stated, that it has been proved before the Committee of the House of Commons, that in fifty-one voyages made by the Admiralty steamers between Falmouth and Corfu, in the four years ending June, 1834, the average speed, exclusive of stoppages, and without allowing for deviation in the course of the vessel, was seven and a quarter miles an hour; and that the vessels performing this had a greater proportion of power to tonnage than can be allowed in longer voyages, and were totally disencumbered of commerce; that the consumption of coals by marine boilers was usually from 10 to 11 lb. a ton; but that, by care, it was sometimes reduced to 9, and sometimes to 8 lb. per ton—taking it at 9 lb. per ton, 1 ton of coals consumed for each horse-power would transport a vessel in the seas between Falmouth and Corfu about 1900 miles; but that he considered the weather to be encountered in the outward voyage to New York at least 25 per cent. worse than the average weather between London and Corfu, and therefore, the locomotive duty of a ton of coals would be reduced to 1425 miles. Taking this as a basis of the calculation, and allowing $\frac{1}{4}$ of a ton of coals per horse-power as spare fuel, the tonnage necessary for the fuel and machinery on a voyage from England to New York would be 3.70 tons per horse-power, which for a vessel with engines of 400 horse-power would be 1480 tons.

If greater average speed were attainable, the resistance would be increased, and the consumption of fuel per mile be likewise increased; therefore, the practicability of the voyage would not be rendered greater. If it be assumed that greater speeds might be attained with the same consumption of fuel per mile, the following table will exhibit, for the several rates of speed expressed in the column A in miles per hour, the tonnage of the vessel which would be occupied by fuel and machinery, allowing in all cases one-fourth of a ton of coals per horse-power, as spare fuel. The first column A expresses the speed in miles per hour; the second B expresses the coals in tons per horse-power, exclusive of spare fuel; the third column C expresses the tonnage per horse-power necessary for coals and machinery, including spare fuel; and the fourth column D expresses the actual stock of coals necessary for a vessel with engines of 400 horse-power, and one-quarter of a ton of spare fuel per horse-power.

Dr. Lardner further explained, that, although from the nature of the projection used on maps, the coast of Nova Scotia appeared to be out of the direct line between England and New York, such, in fact, was not the case: a string stretched upon a globe between Bristol and New York would pass over Newfoundland and Nova Scotia. It appears, therefore, that to touch at Nova Scotia, as recommended, it is not necessary to deviate in the slightest degree from the shortest course to New York.

The excursions and miscellaneous proceedings of the Association have already been described by most of our contemporaries, and being matters of mere temporary interest, do not appear to require further notice from us. One subject, however, we are sorry to say, does call for some remark. It seems to be pretty universally acknowledged that Bristol was most deficient in those courtesies and hospitalities with which at every former place of meeting the Association had been invariably received. This contrast was no doubt the more felt from the warm and cordial reception of the former year at Dublin; but under any circumstances could not be otherwise than most unpleasant to the Members of the Association, and highly discreditable to the place where it occurred. Not many years have elapsed since the name of Bristol was most unhappily associated with the excesses of a wild infuriated populace, and the scarcely less blameable imbecilities of a weak and intimidated magistracy. It is certainly most unfortunate that this ancient city, on the next occasion of being brought prominently forward, should have caused another blot on her already tarnished reputation.

It is gratifying to state that the funds of the Association have allowed no less a sum than 2700l. to be appropriated to the encouragement of scientific inquiries, during the ensuing year. The following is a statement of the grants and recommendations of the several Committees:—

Section A.—Mathematical and Physical Science.

250l. for the discussion of observations on the tides; at the disposal of J. W. Lubbock, Esq.

150l. for observations on the tides in the port of Bristol; Rev. W. Whewell.

70l. for deduction of the constants of lunar nutations, under the direction of Sir Thomas Brisbane, Dr. Robinson, and Mr. Bailly.

30l. for hourly observations of the barometer and lock bull hygrometer; Mr. Snow Harris.

100l. for the establishment of meteorological observations on an uniform plan, and experiments on subterranean temperature. Committee of last year, reduced to Rev. Prof. Powell, W. S. Harris, Esq., Colonel Sykes, and Professor Phillips.

500l. for the procurement of data depending on very accurate measurements of points situated on two straight lines at right angles to each other, for exact determination of the question of permanence or variability of the relative level of the land and sea. Committee: Messrs. Greenough, Lubbock, Mackenzie, Sedgwick, Stevenson, Whewell, Robinson, Bayley, Griffith, Colly, Cubitt, Portlock, and De la Beche. Secretary, Mr. Whewell.

100l. for experimental investigations on the form of waves as influenced by the effect of winds, and the effect of the form of a canal, and the manner in which the wave is produced; John Robison, Secretary R. S. Ed.; and J. J. Russell.

500l. for reductions of observations in the "Histoire Céleste," and Vol. IX. Acad. des Sciences, 1789 and 1790; Messrs. Lubbock, Airy, Bailly, and Dr. Robinson.

150l. for experiments on vitrification; Drs. Turner and Faraday, and Rev. W. V. Harcourt.

80l. for the construction of a rock salt lens; Sir David Brewster.

Section B.—Chemical and Mineralogical.

50l. for researches on the specific gravity of gases; Drs. Henry, C. Henry, and Dalton.

30l. for researches on the quantities of heat developed in combustion and other chemical combinations.

15l. for researches on the components of atmospheric air; Dr. Dalton.

24l. 13s. for the publication of tables of chemical constants; Professor Johnstone.

60l. for researches on the strength of iron made with hot and cold air blasts; Messrs. Fairbairn and Hodgkinson.

Section C.—Geology and Geography.

20l. for experiments on the quantity of mud suspended in the waters of rivers; Rev. James Yates, Messrs. De la Beche and Rennie.

30l. for special researches on subterranean temperature and electricity; R. W. Fox, Esq.

80l. for researches on the nature and origin of peat mosses in Ireland; Colonel Coleby.

Section D.—Zoology and Botany.

25l. for experimental researches on the growth of plants under glass, and excluded from air, according to the plans of Mr. Ward; Professor Henslow.

Section E.—Medicine.

50l. for renewed grant to the committees appointed to investigate the subject of the anatomical relations of veins and absorbents.

50l. for the renewal of a grant to the committees appointed to investigate the subject of the motions and sounds of the heart.

25l. for researches into the chemical constitution of the secreting organs; Drs. Roget, Hodgkin, and Turner, and G. O. Rees, Esq.

25l. for investigations on the physiological influence of cold on man and animals in the Arctic regions; Mr. King.

25l. renewed grant for the investigation of the effects of poisons on the animal economy; Drs. Roupell and Hodgkin.

25l. renewed grant for the investigation of the pathology of the brain and nervous system; Drs. O'Beirne, Green, Macdonald, Messrs. R. O. Michael, R. Adams, and O. Smith.

15l. for the investigation of the physiology of the spinal nerves; Drs. Harpey and Broughton, and E. Cock, Esq.

Section F.—Statistics.

150l. for inquiries into the actual state of schools in England, considered merely as to numerical analysis; Colonel Sykes, and Messrs. Hallam and Porter.

Section G.—Mechanical Science.

501. for an analysis of the reports of the duty of steam-engines in Cornwall; Messrs. J. Taylor, G. Rennie, and Cubitt.

REPORTS IN SCIENCE.

Section A.—Captain Sabine to communicate a continuation of his report on the magnetism of the earth.

Mr. Lubbock to report to the next meeting the result of the deliberations of a committee appointed to consider his proposition for the construction of new empirical lunar tables. Committee: The Astronomer Royal, Professors Rigaud, Challis, and Sir W. R. Hamilton, Messrs. Baily and Lubbock.

Section B.—Professor Johnston to report on the present state of knowledge of the chemical and physical properties of dimorphic bodies in their forms.

Section C.—J. Taylor, Esq., to report on the mineral riches of Great Britain, in relation more particularly to the metalliferous districts.

Section D.—Mr. Yarrell to report on the present state of knowledge of ichthyology.

Section E.—The Rev. W. Taylor, of York, to report on the various methods of printing which have been proposed for the use of the blind.

RECOMMENDATIONS OF RESEARCHES, &c.

Section A.—That Captain Sabine's magnetical observations on the west coast of Scotland form part of the next volume.

That application be made to the French Government for a copy of the best tide observations.

Section B.—That Rev. Mr. Harcourt be requested to continue his experiments on the effects of long-continued heat upon mineral bodies.

Section C.—The attention of members is called to the discovery of plants of any kind in slate rocks of any age older than the coal formation.

In closing our Report we have merely to observe, that after much discussion respecting the place of meeting for the ensuing year, the preference was given to Liverpool, and the time of meeting was fixed in September.

The officers elected for the meeting in 1837, were as follows:

PRESIDENT.—The Earl of Burlington.

VICE-PRESIDENTS.—Dr. Dalton, Sir Philip Egerton, Rev. E. G. Stanley.

SECRETARIES.—Dr. Charles Henry*, Mr. Parker.

GENERAL SECRETARY.—Mr. Murchison.

ELECTRICITY AND GALVANISM.

The following account of a visit to Andrew Crosse, Esq., of Broomfield, on the Quantock Hills, Somersetshire, in September, 1836, was communicated by Sir Richard Phillips to Dr. Mantell, and read at the *Conferences*, Brighton, on Tuesday, Sept. 20:—

While hundreds as well as myself were listening in the Geological Section, at Bristol, to the manly eloquence of Dr. Buckland, the pure intelligence of Professor Sedgwick, the modest elaborations of President Murchison, the shrewd reasoning of Mr. De la Beche, and the honest enthusiasm of Mr. Conybeare, we were further amused by a very original experiment of Mr. Fox, of Penzance, in which, by galvanic action, he had in twenty-four hours converted one state of copper into another state, by an extemporaneous apparatus in a blacking-pot; and we were then surprised by an observation of Dr. Buckland, that he had now to introduce to the Section a philosopher who had made great discoveries by the use of a brick with a hole in it immersed in a pail of water. Mr. Crosse then presented himself, and after laughing at the Doctor's description of his apparatus, began a modest and unprepared account of the results of his experiments on the conversion and production of mineral substances, in which he had been engaged many years. He stated that he had extensive voltaic batteries at work, by which he had formed quartz, arragonite, malachite, &c.; but that, as such formations were slowly produced, so he had latterly used no acid in his combinations, but only pure water. He detailed various results of different experiments, some successful and some failures, and in his impassioned descriptions of the latter he created much merriment. The most lively bursts of satisfaction proceeded from all who were present during these details; and Professor Sedgwick then announced his recognition of Mr. Crosse, as an electrician, the magnitude of whose experiments had surprised him during a mineralogical excursion in the Quantock Hills, about seventeen years before.

All that passed, as well as the rustic appearance and manners of Mr. Crosse, created an opinion that he was a very obscure individual, who, in an original and untaught manner, had pursued the objects of electricity and galvanism with the limited views of his class of experimenters. Nevertheless, he gave a general invitation to all who chose to visit his retreat in the Quantock Hills, and expressed his readiness to show them his apparatus and the present state of his experiments.

The originality of the circumstance determined me at once to accept his invitation, and the day after that on which the business of the Association was finished, I proceeded to Bridgewater, from which Broomfield is distant about eight miles in the hill country.

In my route I could not avoid turning my attention to those phenomena of atoms which result from the disturbance or excitement, called electric; and from their restoration to their usual fit state of co-existence, with a force equal to the existing force, but capable of condensation into burning and dispersing points.

Since I experimented with electricity 48, 47, and 46, nearly 50 years ago, I have always regarded it as a regular disturbance of the atoms combined in fit and necessary relations in an electric stratum or space, when bounded or stopped by a surface which is a non-electric. I regard the atoms so electrically arranged as the same atoms which, under other modes of excitement, produce tones in music or colours of light. In the mode of excitement produced by electricity, as its effect we produce a chemico-mechanical arrangement in strata ascending from the boundary or obstructing surface, producing parallel strata, a vertical section of which would nearly correspond with our scale of prismatic colours, or our divisions of the octave in music; but we are to bear in mind that in this case it is a chemico-mechanical effect which we have to consider, that is, an arrangement of the relative powers of atoms, in regard to their different sets, and at the same time all powers of matter, and of atoms of matter, are to be regarded as mechanical.

Then, as we know that in sound we have octave upon octave, and, in light, spectra overlaying each other, so we may analogically assume that the arrangements of the strata involve some, at least, of the sets of atoms, so as to explain those phenomena which in some instances do not appear to be governed by our popular and more obvious division of the permanent gases into oxygen, nitrogen, and hydrogen.

In this view of the subject we see why, in every case of electrical display or action, positive and negative must always exist together—why electricity must always be thought of as a combination of positive and negative—why it is a decision to speak of electricity as connected positively or negatively with any simple body—and, in a word, why, if we think at all, or know the letter A in the alphabet of its science, we can in no way contemplate it but as a whole in its positive end or side, and in its negative end or side. In this view the wonder about distant induction ceases. It is true that we often see but one side, as a metal plate, or a prime conductor, or an exciting cylinder or plate; but as the action is not in those but in the adjoining space, so the walls of the room, the furniture, and the bodies of operators, become the boundary surfaces, and are in an opposite electrical state; or in other cases, in the open air, the atmosphere generates in distance a boundary surface; but in both these cases the re-action is diffused, and the effects are as much less than when another fit surface is presented to the first surface so as to condense and confine the expansion of the action within definite limits.

An electric, as air, glass, &c., is therefore a space containing the elementary atoms susceptible of separation, and of becoming by the separation capable of displaying contrasted action on two of its sides. A non-electric is a body whose elements cannot be separated by this mode of action, and it is, therefore, as it is more or less insusceptible, an obstructor or stop to the action of the adjoining electric, and in that case the stratum of the electric is spread over it by the perpendicular re-action of the obstructing surface. In that case only is it a conductor; but as far as it partakes or is susceptible of the action it is a non-conductor.

We have now to consider what takes place on the restoration of a volume of the atmosphere or electric. An undisturbed volume of atoms combines with certain natural fitness or force, and in all electrical excitement the usual arrangements are disturbed by some force which deranges the equilibrium, and a force therefore exists between the two sides of a plate by which they seek to re-unite, and hence the attractions and counter-attractions of light bodies between two plates in contrary electricities. When left at rest, restoration is an effect of the action and re-action of the surrounding air and the disturbed plate; but we more commonly restore the electrical strata to the equilibrium of co-mixture, by the direct communication of a spark through a projection, which, in diminishing the distance, assembles the force of an extended surface in its diminished dimensions. To explain this we must reflect on what has been observed about the increase of force by limiting the space by an opposed or approximative stop. In an electrified volume we may conceive of the strata nearly as of the strata of the earth, except that in the electrified strata there is an active force exerting itself. To leave the stratified form and return to co-mixture.

We have other instances of light created in the atmosphere by rapid motion, but if it be objected that our distribution of atmosphere into oxygen and nitrogen does not imply the presence of hydrogen, I would then appeal to the opinions of Berzelius and other chemists about nitrogen, to the fact that the spark itself implies the presence of hydrogen or its principle, and that

different bodies give different colours to the spark; and in fine, that I rather appeal to the principles than to the atoms commonly so called, and which may in this case be the patients rather than the causes; while it is notorious that all regular, electrical, and galvanic phenomena are intimately connected with the effects of the principles, oxygen and hydrogen.

But Mr. Crosse works with the voltaic apparatus, and ought we not rather to consider that? To this I reply, that electricity and galvanism are identical, and a confirmation of that has been previously stated. We put between plates of different powers of oxydation, acidulous compounds, with water—we get electrical action directly, as one of the plates oxydates for our positive pole; and we obtain a generation of hydrogen on the other plate for the negative pole. The disturbed surfaces are then united by a better continuator than the fluid between the plates, and the opposite conditions proceed along wires to restoration. The currents, where their proximity increases, then force parts of bodies placed in their course, each its contrary elements, and all its miracles of voltaic poles. In general a violent dispersive power has been employed, and electricians have laid their glory in the force and dispersive effect of their apparatus; but Mr. Crosse has had the wise and modest ambition to employ a low power, so as in long time to generate and combine instead of destroying and dispersing. In this variation he happily studied the process of nature, and has in consequence been able to imitate them.

On reaching the handsome mansion of Mr. Crosse, situated in an undulating park, studded with trees of great bulk and age, I was received with much politeness, and found that I was the first visitor from Bristol. As I was preparing to return my conveyance to convey me back to Bridgewater, I was requested to return it, and pressed to stay to dinner and take a bed. Breakfast being well served, Mr. Crosse then conducted me into a large and lofty apartment, built for a music room, with a capital organ in the gallery, but I could look at nothing but the seven or eight tables which filled the area of the room, covered with extensive voltaic batteries of all forms, sizes, and extents. They resembled battalions of soldiers in exact rank and file, and seemed innumerable.

They were in many forms, some in porcelain troughs of the usual construction, some like the couronnes des tasses, others cylindrical, some in pairs of glass vessels, with double metallic cylinders; besides them, others of glass jars, with stripes of copper and zinc. Altogether there were 500 voltaic pairs at work in this great room, and in other rooms about 500 more. There were besides other 500 ready for new experiments. It seemed like a great magazine for voltaic purposes.

There are also two large workshops, with furnaces, tools, and implements of all descriptions, as much as would load two or three waggons.

In the great room there is also a very large electrical machine, with a 20 inch cylinder, and a smaller one, and in several cases all the apparatus in perfect condition, as described in the best books on electricity. The prime conductor stood on glass legs, two feet high, and there was a medical discharger on a glass leg of five feet. Nothing could be in finer order, and no private electrician in the world could, perhaps, show a greater variety both for experiments and amusement.

Beneath the mahogany cover of a table, on which stood the prime conductor, &c., was enclosed a magnificent battery of 50 jars, combining 73 square feet of coating; its construction, by Cuthbertson, was in all respects most perfect. To charge it required 250 vigorous turns of the wheel, and its discharge made a report as loud as a blunderbuss. It fuses and disperses wires of various metals; and the walls of the apartment are covered with framed impressions of the radiations from the explosion taken at sundry periods. Mr. Crosse struck one while I was present, and he has promised me one as an electrical curiosity and a memento of my visit.

But Mr. Crosse's greatest electrical curiosity was his apparatus for measuring, collecting, and operating with atmospheric electricity. He collects it by wires the 16th of an inch, extended from elevated poles to poles, or from trees to trees in his grounds and park. The wires are insulated by means of glass tubes well contrived for the purpose. At present he has about a quarter of a mile of wire spread abroad, and in general about the third of a mile. A French gentleman had reported to the Section at Bristol that the wires extended twenty miles, filling the entire neighbourhood with thunder and lightning, to the great terror of the peasantry, who in consequence left Mr. Crosse in the free enjoyment of his game and rabbits. This exaggeration Mr. Crosse laughed at most heartily, though he acknowledged that he knew that no small terror prevailed in regard to him and his experiments.

The wires are connected with an apparatus in a window of his organ gallery, which may be detached at pleasure, when too violent, by simply turning an insulated lever; but in moderate strength it may be conducted to a ball suspended over the great battery, which connected with it is charged rapidly, and is then discharged by means of an universal discharger. He told me that sometimes the current was so great as to charge and discharge the great battery twenty times in a minute, with reports as loud as cannon, which being continuous were so terrible to strangers that they always fled, while every one expected the destruction of himself and premises. He was, however, he said, used to it, and knew how to manage and control it; but when it got into a passion he coolly turned his insulating lever, and conducted the lightning into the ground. It was a damp day, and we regretted that our courage could not be put to the test.

1. A battery of 100 pairs of 25 square inches, charged like all the rest with water, operating on cups containing 10z. of carbonate of barytes and powdered sulphate of alumine, intended to form sulphate of barytes at the positive pole, and crystals of alumine at the negative.

2. A battery of 11 cylindrical pairs, 12 inches by 4. This, by operating six months on flat of silver, had produced large hexahedral crystals at the negative pole, and crystals of silica and chalcidol at the positive.

3. A battery of 100 pairs of 4 square inches, operating on slate 832, and platina 3, to produce hexagonal crystals at the positive pole.

4. A battery of 100 pairs, 5 inches square, operating on nitrate of silver and copper, to produce malachite at the positive pole; at the negative pole, crystals already appear with decided angles and facets.

5. A battery of 16 pairs of 2 inches, in small glass jars, acting on a weak solution of nitrate of silver, and already producing a compact vegetation of native silver.

6. A battery, esteemed his best, of 813 pairs, 5 inches insulated on glass plates on deal bars, coated with cement, and so slightly oxydated by water as to require cleaning but once or twice a year by pumping on them. I felt the effect of 458 pairs in careless order and imperfectly liquidated, and they gave only some tinglings of the fingers, but this power in a few weeks produces decided effects.

7. A battery of 12 pairs, 25 inches zinc and 36 copper, charged two months before with water, and acting on a solution of nitrate of silver, poured on a green-bottle glass coarsely powdered. It had already produced a vegetation of silver at the positive pole.

8. A battery of 159 galley-pots with semi-circular plates of 14 inch radius placed on glass plates, and acting five months through a small piece of Bridgewater porous brick, on a solution of ailex and potash. I saw at the poles small crystals of quartz.

9. A battery of thirty pair, similar to No. 8, acting since July 27th, on a mixture, in a mortar, of sulphate of lead, of white oxide, of antimony, and sulphate of copper, and green sulphate of iron (205 grains), and three times the whole of green-bottle glass (645 grains). The result has been, in five weeks, a precipitation on the negative wire of pure copper in two days, and crystallized iron pyrites in four days. It had been expected to produce sulphates of lead, copper, and antimony, by depriving the sulphates of their oxygen. On August 10th and 26th, 25 grains and 40 grains of sulphate of iron were added.

10. A battery of five jars, with plates of different metals, as two copper and platina, one of lead and lead, and one silver and iron, and one copper and lead.—Experimental.

11, 12, and 13. About 200 pairs, in three batteries, working in a dark room, of which I took no note.

While I was an inmate with Mr. Crosse, we had various conversations about the power which he employed. I had in some degree anticipated his debut, by hazarding in the last edition of my "Million of Facts, 1835," an assertion that, inasmuch as metals are found only in a mixed or confused state of different rocks, among which a galvanic action on air or water would necessarily arise, and in long time generate the compound matrices of metals; but I did not regard this public anticipation as any interference with his original merits, and I was deeply penetrated by the view of his labours, and the expense and zeal with which he had prosecuted his experiments. Yet he had a round conductor for a minimum of power, instead of a combination of flat or parallel ones for a maximum. And he could not help talking about the fluid, and some other fancies of the elder electricians, who invented their doctrines before it was suspected that air was a compound, and that such active powers as oxygen, nitrogen, hydrogen, and their definite numerical co-mixtures, conferred mechanical character on the most refined operations of nature.

He instructed me in the fact that his batteries performed four times the duty in those hours in the morning, from seven to eleven, when the great laboratory of nature is evolving the most oxygen, than in the same period in the evening, when we may imagine the contrary effect takes place. He considered the air as so non-electric in damp weather, that no plate of air, lying between the coating of a cloud and the earth, could then be disturbed, and he stated to me as a general fact that the earth is always positively electrified.

On my part I enlarged to him and his son on the universality of matter and motion in producing all material phenomena, independently of the whimsical powers invented in ages when he would have been burnt for a magician, and in this way I endeavoured to return the various information which he had so unreservedly imparted to me. I impressed on him that all this creative energy of atoms was merely a display of developments by the great motions of the earth as they affect the excitable parts of different solid bodies; the

results of which are necessarily regular, and their ultimate laws of re-action and combination also regular so as to produce that universal harmony which surprises beings who, in eternal time, live and observe only within a unit of time. Hence that terrestrial galvanism arising from the operations of the internal frictions and varied pressures called heat; hence those factitious productions of metallic matrices and crystalline forms resulting from refined and subtle actions which confer electrical and galvanic effects, where different substances are proximately opposed; hence magnetism itself tangentially displayed as a resultant of terrestrial currents of electricity; hence the fluctuations of the phenomena from obliquity of the axis of rotation which, in regard to the axis of the orbit, generates two variable directions of massive pressure; hence, in fine, the wisdom displayed by Mr. Crosse in resorting to the *modus operandi* of nature in his attempts to imitate her most curious productions. Observing that continued fresh arrivals rendered it ineligible for me to prolong my visit, I proceeded to Taunton, a distance of six or seven miles, the nearest place at which a stranger can meet with public accommodation.

REVIEWS.

London and Edinburgh Philosophical Magazine, No. 54, Oct. 1836. Longman and Co.

In the number for the present month we have several interesting articles, and the number may be said to be good, although we must admit we have seen far better. Amongst those articles to which our attention has been attracted, may be enumerated one by Mr. W. C. Williamson, Curator of the Museum of the Manchester Natural History Society, and communicated by the author "on the Limestones found in the vicinity of Manchester." This paper, which is to be continued in the number for the next month, treats the subject in a familiar and pleasing manner. We select on the present occasion the Section on Fossil Remains, and shall, on the completion of the paper, give an abstract of the views of the writer.

"The fossils of the magnesian limestone are neither numerous nor of peculiar interest; they chiefly consist of *Asinus obscuro*, *Avicula*, *Crassina*, *Trochus*, and several varieties of minute turritinated shells, probably species of *Turbo*. The *Asinus obscuro* of Collyhurst differs only from those of Bedford and Yorkshire in having a regular series of concentric striae on its external surface. These I have observed in impressions of some of the above places; but neither the granular limestone of Bedford nor the calcareous shelly marl of Yorkshire, is so well calculated to preserve the delicate character of the shells as the fine clay of Collyhurst. The *Asinus* is found in every stage of growth, and at both localities, with the exception of one single specimen from Bedford, consists entirely of single valves. From this it would appear that the shells had been gradually covered up, the ligaments being destroyed before they were buried, and protected from decomposition and disunion of the valves.

"I am uncertain whether the *Avicula* be an undescribed species or not, but rather suppose it is. It approaches closely to *Avicula socialis* of Sowerby, which has induced some to consider the stratum as identical with the muschelkalk. I believe Professor Phillips is of opinion that the species is undescribed. The *Trochus*, which is a small and beautifully granulated one, as well as the minute turritinated shells, are certainly new, although some of them may be referred to by Professor Sedgwick, in his paper on the magnesian limestone of Yorkshire, without either figure or description. Two or three smaller bivalve shells occur, one of which, I believe, is *Crassina*, but as they are only casts, the species cannot easily be determined. The most important fossil is the *Asinus*, as from its extreme abundance in the magnesian limestone of Yorkshire it formed a ready means of identification.

"From this it will be seen that the magnesian limestone of the neighbourhood of Manchester is an unimportant bed compared with that of many other districts. The German zeekstein and kupferschiefer have their remains of the Monitor and Palæotrissium, together with the peculiar impressions of *Fucoides*. The limestones of Durham and Northumberland have their *Zoophyta* and *Radiaria*, with numerous Mollusca and remains of fish. In Yorkshire are thick ranges of a yellow lamellar limestone, so well exhibited on the line of the Leeds and Selby Railway, literally teeming with beautiful specimens of *Asinus*; and here we have only a few unimportant beds of limestone, almost lost amongst the clays in which they occur, and only exhibiting a few casts of fossils, of which but one or two (the specific characters of which are so striking as not to be mistaken) can be distinctly recognised."

"Some experiments on the supposed new metal Domium," are narrated by Mr. J. D. Smith, notice of which must be deferred, as must also Dr. Schoenbein's "Observations on the Action of Nitric Acid upon Iron," both of which are of interest.

Repertory of Patent Inventions, No. 34, Oct. J. S. Hodson.

Another number of this work is before us, and calls from us but little observation. Its contents are principally the "Specifications of Patents," in which there are none applicable to our pages. The conclusion of the report of the India-rubber cause, "Cornish and another v. Keene and another," has been again stretched out so as to form part and parcel of the present number, which, however, is brought to a conclusion; this, with "Expired and New Patents," as before reported, form the contents, which, after all, we must repeat are dear at the money, although we are ready to admit the work to be useful, and to many, indispensable.

The American Journal of Science and Arts. By BENJAMIN SILLIMAN, M.D., LL.D., &c. A. H. Maltby, Newhaven.

We are at all times glad to receive a number of this useful and instructive work, and the present gives us only reason to congratulate its talented editor on the support he receives, evinced by the value of the several articles which appear, although we must admit some of the former numbers have afforded us more general information. It is true that we look over its pages with a view to select alone articles for extract treating on geology and mineralogy; and while we confine ourselves to these subjects, it is at least only justice to admit the value and importance of others, not immediately coming under our notice. On the present occasion, we have only to express our satisfaction on receiving the present number, leaving, until an opportunity is afforded us of entering into detail, a notice of the several papers, among which the notice of a scientific expedition, by Professor E. Emmons, is well deserving of attention.

The Engineers' and Mechanics' Encyclopedia, Part 12.

Luke Hebert. Thomas Kelly.

This work, which is approaching to completion, continues its course favourably, so as to justify the opinions which the early numbers induced us to form; and although occasionally we find "old news," the manner in which the publication is got up, with the information collected, are such as to do justice to all parties concerned. We find that our extracts have been considered to have done the work too much justice, while they did us, (or, as we hoped, our readers,) some service; we therefore avoid saying more on the present occasion than to express our hope that the work, as one directed to science, and useful to the mechanic, may meet the reward it justly merits, but which unfortunately too seldom awaits publications of this nature.

FOSSIL REMAINS.—M. Larrey recently presented to the French Academy of Sciences the fossil head of a bear, called the great cavern bear by Cuvier. It was found in the grotto of Milet, department of Gard. It does not appear that there at present exists any species at all resembling it, and the excellent state of preservation in which it was discovered induced M. Larrey to purchase it. M. St. Hilaire was charged with its examination, for the purpose of drawing up a report upon it.

CLIMATE.—The healthiness of the Cape district is evinced by the fact that, in 1830, out of a population of 1500 Hottentots in Holland, the total number of deaths was only five; of which four were coloured persons, and an old Mozambique, another an old slave, both of whom died of chronic diseases; the third a young child, died suddenly; the fourth, a Caffre girl, was burnt, and the fifth (a European gentleman of fifty) principally of a mental affection. The mean temperature of Cape Town (which is heated by its proximity to Table Mountain); inferred from a Meteorological Journal kept for several years, is 67°. The mean temperature of the coldest month is, perhaps, 57; hottest, 79; mean of three recent winters, 58; of three summer months, 77; least heat during summer, 63.—Colonial Library, Cape of Good Hope.

PROPERTIES OF IVY.—Cato and Pliny attribute a singular property to the wood of the ivy, and say that, by its filtering powers, it can separate wine from water. According to these authors, if a cup of ivy wood be filled with wine that has been adulterated with water, the wine will find its way through the pores of the wood, and the water alone will remain in the cup. In the *Notion Du Hamel* it is mentioned that this experiment was tried by a person worthy of confidence, and that he found the very reverse take place; the water filtering through, and the wine remaining in the cup.—*Arboretum Britannicum*.

* The melancholy death of this gentleman, shortly after the meeting, will be in the recollection of our readers.

JOINT-STOCK BANKS.

(Continued from page 12.)

STOURBRIDGE AND KIDDERMINSTER BANK.

Commenced April, 1834, at Stourbridge, and June, 1834, at Kidderminster; has two branches and four agencies, the nearest seven, the farthest twenty-one miles; nominal capital, 250,000l.; 10,000 shares of 25l. each; 9000 shares issued; capital paid up, 45,000l.; dividend 6 per cent.; date of deed of settlement, March, 1834, signed by 267; has a lien on all shares held by customers indebted to the bank; pays promissory notes at Stourbridge, Kidderminster, Stratford-on-Avon, and in London; pays from 2 to 3 per cent. on deposits and balances; account made up to the 21st of May, 1836.

GLOUCESTERSHIRE BANKING COMPANY.

Commenced July, 1831; has four branches, the nearest eight, the farthest twenty-five miles distant; nominal capital 500,000l.; 10,000 shares of 50l. each; 10,000 shares issued; capital paid up, 100,000l.; dividend in 1832, 6 per cent.; in 1833, 1834, and 1835, 10 per cent.; date of deed of settlement, July, 1831, signed by all the original subscribers, 300; deed printed, July, 1831; pays 2½ per cent. on deposits, nothing on running accounts; account made up to December 31, 1835.

EAST OF ENGLAND BANK.

Commenced February, 1836; has four branches and twelve agencies, the nearest twenty-one, the farthest forty-three miles; nominal capital, 1,000,000l.; 50,000 shares, 20l. each; 15,878 shares issued; capital paid up, 75,752l.; date of deed of settlement, May, 1836, in course of signature; has a lien on all shares in case of need; pays promissory notes at Norwich, Ipswich, Great Yarmouth, Bury St. Edmund's, and in London; pays 2 per cent. on deposits and balances; account made up to the 21st of May, 1836.

YORKSHIRE DISTRICT BANK.

Commenced August 1834; has eighteen branches; head office, Leeds; the nearest fifteen, the farthest fifty-two miles distant; nominal capital, 1,000,000l.; 50,000 shares, 20l. each; 31,211 shares issued; capital paid up, 311,110l.; dividend 5 per cent.; date of deed of settlement, August, 1834, signed by 665; has a lien on all shares in case of need; pays promissory notes at Leeds, at all the branches, and in London; pays 2½ per cent. on deposits, and 3 per cent. on current accounts; account made up to the 21st of May, 1836.

NORTH WILTS BANKING COMPANY.

Commenced November, 1835; has eleven branches, the nearest five, the farthest twenty-four miles distant; nominal capital, 250,000l.; 10,000 shares, 25l. each; 7385 shares issued; capital paid up, 36,925l.; date of deed of settlement, October, 1835, with 157 signatures; holds seventy-five shares in its own right, and 150 on security; pays 2½ per cent. on deposits, nothing on balances; account made up to the 31st of May, 1836.

LEEDS AND WEST RIDING BANKING COMPANY.

Commenced October, 1835; has three branches, the nearest seven, the farthest fifteen miles distant; nominal capital, 400,000l.; 20,000 shares, 20l. each; 9000 shares issued; capital paid up, 45,000l.; date of deed of settlement, January, 1836, signed by 147 persons; has a lien on all shares in case of need; pays promissory notes in Leeds and London; pays 3 per cent. on deposits for three months, and 2 per cent. on current balances; account made up to the 30th of June and 31st of December.

THE HAMPSHIRE BANKING COMPANY.

Commenced May, 1834; has two branches, seven and twelve miles distant; nominal capital, 300,000l.; 6000 shares, 50l. each; 4834 shares issued; capital paid up, 24,170l.; dividend 7½ per cent.; date of deed of settlement, July, 1834, signed by 143 shareholders; pays promissory notes and bank-post bills at Southampton and London; pays 2½ per cent. on deposits for three months; no interest on running accounts; account made up to the 30th of June, 1835.

DEVON AND CORNWALL BANKING COMPANY.

Commenced January, 1832; has nine branches, the nearest two, the farthest thirty-six miles distant; nominal capital, 300,000l.; 3000 shares, 100l. each; 2019 shares issued; capital paid up, 40,380l.; dividend, first year, 5 per cent.; second and third years, 6½ per cent.; fourth and fifth years, 7½ per cent.; date of deed of settlement, November, 1832, with 135 signatures; has a lien on all shares of customers indebted to the bank; pays promissory notes and bank-post bills at Plymouth, Devonport, Kingsbridge, St. Austle, and Totnes; pays 3 per cent. on deposits; account made up to the 31st of December, 1835.

BARNLEY BANKING COMPANY.

Commenced February, 1832; has no branches; nominal capital, 300,000l.; 3000 shares, 100l. each; 2515 shares issued; capital paid up, 25,150l.; dividend, from February, 1832, to December, 1833, 7½ per cent.; from December, 1833, to December, 1834, 6 per cent.; and 6½ per cent. to December, 1835; date of deed of settlement, May, 1832, signed by 129; pays promissory notes at Barnley only; pays 2 per cent. on deposits from two to six months, 2½ per cent. on deposits for six months and upwards; 3 per cent. on accounts when commission is charged, and 2 per cent. without commission; accounts made up to December 31, 1835.

NORTHERN AND CENTRAL BANK OF ENGLAND.

Commenced March, 1834; has twenty-seven branches and six sub-branches, the nearest six, the farthest 110 miles distant; 100,000 shares of 10l. each; 71,186 shares issued; capital paid up, 711,860l.; dividend 7 per cent.; date of deed of settlement, July, 1834, signed by 1265 persons; deed printed; has a lien on all shares in case of need; pays promissory notes at all the branches and in London; pays from 2½ to 3½ per cent. on deposits and balances, according to agreement; accounts made up to December 31, 1835.

COMMERCIAL BANK OF ENGLAND.

Commenced August, 1834; has eighteen branches, the nearest eleven, the farthest seventy miles distant; capital paid up, 260,000l.; 100,000 shares, 5l. each; 52,001 shares issued; dividend 8 per cent., or 6 per cent. per annum; date of deed of settlement, May, 1834; signatures to it, 637; deed printed; holds 682 shares in its own right, bought shares; has a lien on all shares if necessary; pays promissory notes in London; pays from 2½ to 3½ per cent. interest on deposits and balances; accounts made up to June 10, 1836.

BANK OF LIVERPOOL.

Commenced May, 1831; has no branches; nominal capital, 3,000,000l.; 30,000 shares, 100l. each; 25,810 shares issued; capital paid up, 258,100l.; dividend, 31st December, 1832, at the rate of 6 per cent.; 1833, 6 per cent.; 1834, 6 per cent.; 1835, first half-year, 7 per cent.; second half-year, 8 per cent.; date of deed of settlement, August, 1831, signed by 580; deed printed; has a lien on all shares in case of need; pays 2½ per cent. on deposits; keeps current accounts at 3½ per cent., charging ¼ per cent. commission on the debit side; accounts made up to 31st December, 1835.

THE STAMFORD AND SPALDING JOINT-STOCK BANKING COMPANY.

Commenced January, 1832; has three main stations and three branches; nominal capital, 150,000l.; 300 shares, 500l. each; 220 shares issued; capital paid up, 44,000l.; dividend 7½ per cent.; date of deed of settlement, January, 1832, signatures to it, 108; has a lien on all shares if necessary; holds two of its own shares for insolvent creditors; advances on shares fluctuates between 8000l. and 10,000l.; pays 2½ per cent. on balances, and 3 per cent. on deposits; accounts made up to June, 1836.

LEAMINGTON BANK.

Commenced May, 1835; has no branches; nominal capital, 200,000l.; 10,000 shares, 20l. each; 6180 shares issued; capital paid up, 25,710l.; date of deed of settlement, May, 1835, signed by 146; pays from 2 to 3 per cent. on deposits and balances; account made up to December 31, 1835.

Commenced April, 1834; has five branches, the nearest fourteen, the farthest thirty miles distant; nominal capital, 500,000l.; 10,000 shares, 50l. each; 6261 shares issued; capital paid up, 62,610l.; dividend 6 per cent.; date of deed of settlement, April, 1834, signed by 285; deed printed; pays 3 per cent. on deposits and balances.

SHEFFIELD BANKING COMPANY.

Commenced July, 1831; has one branch at Rotherham; nominal capital, 300,000l.; 1500 shares, 200l. each; 1381 shares issued; capital paid up, 75,955l.; dividend in 1832, 4 per cent. for half-year; in 1833, 10 per cent.; in 1834, 10 per cent.; 1835, 8 per cent.; date of deed of settlement, January, 1832, signed by 200 persons; deed printed; has a lien on all shares for advances; pays promissory notes at Sheffield and Rotherham; pays 2 per cent. on deposits for three months, 2½ per cent. for six months, 3 per cent. for twelve months; 2½ per cent. on balances with customers, and 3 per cent. with other banks; account made up to December 31, 1835.

WALSALL AND SOUTH STAFFORDSHIRE BANK.

Commenced August, 1835; has one branch, eight miles distant; nominal capital, 200,000l.; 8000 shares, 25l. each; 5000 shares issued; capital paid up, 25,000l.; date of deed of settlement, July, 1835, signed by 109; deed printed, January, 1836; pays from 2 to 3 per cent. on deposits and balances; account made up to May 31, 1836.

ROYAL BANK OF LIVERPOOL.

Commenced May, 1836; has no branches; nominal capital, 2,000,000l.; 20,000 shares of 1000l. each; 876 shares issued; capital paid up, 91,900l.; pays 2½ per cent. on deposits; 3 to 3½ per cent. on balances, subject to a commission of ¼ per cent.; account made up to 21st of May, 1836.

LEICESTERSHIRE BANKING COMPANY.

Commenced September, 1829; has four branches, the nearest fifteen, the farthest seventeen miles distant; nominal capital, 500,000l.; 5000 shares, 100l. each; 3191 shares issued; capital paid up, 47,865l.; dividend in 1831, 4 per cent.; in 1832, 4½ per cent.; in 1833, 4½ per cent.; in 1834, 5 per cent.; in 1835, 6 per cent.; and in 1836, 7½ per cent.; date of deed of settlement, August, 1829; signatures to it, 130; deed printed; has a lien on all shares in case of need; pays 2½ per cent. on deposits, and 3 per cent. on current accounts, subject to a commission; account made up to the 30th of June and 31st of December.

CHESTERFIELD AND NORTH DERBYSHIRE BANKING COMPANY.

Commenced January, 1834; has no branches; nominal capital, 250,000l.; 2500 shares, 100l. each; 2320 shares issued; capital paid up, 23,200l.; dividend 6 per cent.; date of deed of settlement, May, 1834, signed by ninety-eight; holds 180 unappropriated shares, and has a lien on 800 shares, on which advances have been made; pays 2½ per cent. on deposits and balances; account made up to December 31, 1835.

LEAMINGTON-PRIORS AND WARWICKSHIRE BANKING COMPANY.

Commenced September, 1835; has four branches, the nearest two miles and a half, the farthest twenty miles distant; nominal capital, 200,000l.; 10,000 shares, 20l. each; 3670 shares issued; capital paid up, 22,020l.; date of deed of settlement, September, 1835; pays 2½ per cent. on deposits; account made up 31st of March, 1836.

BRADFORD COMMERCIAL JOINT-STOCK BANK.

Commenced March, 1833; has no branches; nominal capital, 500,000l.; 5000 shares, 100l. each; 2940 shares issued; capital paid up, 44,100l.; dividend in 1834, 7½ per cent.; 1835, 7 per cent.; and February, 1836, 7 per cent.; date of deed of settlement, February, 1833, signed by 163; pays promissory notes at Bradford; pays 3 per cent. on deposits, and 2½ per cent. on balances; account made up to the 31st of December, 1835.

NATIONAL PROVINCIAL BANK OF ENGLAND.

Commenced January, 1834; has thirty branches and twenty-three sub-agencies; nominal capital, 1,000,000l.; to be increased 200,000l.; 10,000 shares of 100l. each, 10,000 shares of 20l. each; all the 100l. shares issued, 20l. shares issued; capital paid up, 250,000l., to be called on the 20l. shares, 100,000l.; dividend 5 per cent.; date of deed of settlement, September, 1833, signed by 508; promissory notes paid where issued; pays from 2½ to 3 per cent. on deposits for three months.

DERBY AND DERBYSHIRE BANKING COMPANY.

Commenced January, 1834; has two branches, seven and thirteen miles distant; nominal capital, 250,000l.; 5000 shares, 50l. each; 4000 shares issued; capital paid up, 20,000l.; dividend 6 per cent.; date of deed of settlement, November, 1833, signed by 204; deed printed; pays promissory notes and bank-post bills in Derby and London; pays 2½ per cent. on deposits; account made up to the 31st of December, 1835.

WARWICK AND LEAMINGTON BANKING COMPANY.

Commenced September, 1834; has four branches, the nearest two, the farthest ten miles distant; nominal capital, 250,000l.; 10,000 shares, 25l. each; 6260 shares issued; capital paid up, 31,310l.; dividend 6 per cent.; date of deed of settlement, September, 1834, signed by 135; holds forty-five shares in its own right; pays promissory notes at all the branches and in London; pays, never exceeding, 2½ per cent. on deposits and balances; account made up to the 31st of December, 1835.

NORTH OF ENGLAND JOINT-STOCK BANKING COMPANY.

Commenced December, 1832; has four branches, the nearest seven, the farthest sixty miles distant; nominal capital, 2,000,000l.; 20,000 shares, 100l. each; 16,000 shares issued; capital paid up, 240,000l.; dividend for the half-year ending December, 1833, 3 per cent., and 3l. 6s. for the year ending December, 1835; date of deed of settlement, November, 1832, signed by 629; has a lien on all shares for debts due to the bank; promissory notes payable at Newcastle only, but when presented at the branches are not refused; pays 3 per cent. on deposits; account made up to December 31, 1835.

BANK OF WESTMORELAND.

Commenced July, 1833; has one branch at Ulverston; nominal capital, 250,000l.; 2500 shares, 100l. each; 2025 shares issued; capital paid up, 20,950l.; dividend of 12s. per share declared in July, 1835; date of deed of settlement, April, 1834, signed by 164; holds 405 unappropriated shares; pays promissory notes at Kendal only; pays 2½ and 3 per cent. on deposits and balances; account made up to December 31, 1835.

MANCHESTER AND LIVERPOOL DISTRICT BANKING COMPANY.

Commenced December, 1829; has fourteen branches and eight sub-branches, the nearest six miles and a half, the farthest fifty-two miles distant; nominal capital, 5,000,000l.; 5000 shares, 100l. each, all issued; capital paid up, 749,600l.; dividend, March, 1831, 5 per cent.; 1832, 5 per cent.; 1833, 6 per cent.; 1834, 7½ per cent.; 1835, 7½ per cent.; and, in March, 1836, 7½ per cent.; date of deed of settlement, June, 1830, signed by 834; holds 1037 shares in its own right; pays promissory notes at the places where issued; pays from 2½ to 3 per cent. on deposits and balances; account made up to the 31st of December, 1835.

WILTS AND DORSET BANKING COMPANY.

Commenced December, 1835; has twenty-one branches, the nearest twenty-two, the farthest fifty-four miles distant; nominal capital, 300,000l.; 20,000 shares of 15l. each; capital paid up, 42,672l.; 275 shares forfeited by non-payment of instalments; date of deed of settlement, December, 1835, in course of signature; pays 2½ per cent. on deposits, and 2 per cent. on balances; account made up to June 4, 1836.

LANCASTER BANKING COMPANY.

Commenced October, 1826; has two branches, each twenty-two miles distant; nominal capital, 300,000l.; 3000 shares of 100l. each; 2430 shares issued; capital paid up, 48,600l.; dividend in 1827, 1828, 1829, 1830, 1831, 1832, and 1833, 5 per cent.; in 1834, 7½ per cent., and 1835, 10 per cent.; date of deed of settlement, September, 1826, signed by seventy-eight; deed printed; holds 570 shares in reserve; pays promissory notes where issued; pays 3 per cent. on deposits, and 3½ per cent. on balances, subject to ¼ per cent. commission.

BANK OF MANCHESTER.

Commenced March, 1829; has three branches, the nearest seven, the farthest ninety miles distant; nominal capital, 2,000,000l.; 20,000 shares of 100l. each, all issued; capital paid up, 500,000l.; dividend second, third, fourth, and fifth years, 6 per cent.; sixth year, 7 per cent.; date of deed of settlement, March, 1829, signed by 544; deed printed; promissory notes payable at Manchester and London; pays 2½ per cent. on deposits, and 3 to 4 per cent. on accounts current; account made up to June, 1835.

BANK OF BIRMINGHAM.

Commenced August, 1832; has no branches; nominal capital, 500,000l.; 10,000 shares, 50l. each; 7642 shares issued; capital paid up, 73,785l.; dividend, 10 per cent.; date of deed of settlement, August, 1832, signed by 290; 5l. and 10l. notes forming the greater proportion of the circulation, paid either in Birmingham or London; pays 3 per cent. on deposits, sometimes 3½ per cent.; account made up to December 31, 1835.

METHOD OF TURNING LARGE CASTINGS.—We had this week the pleasure of witnessing in operation a new method of iron-turning first applied by Messrs. Barr and McNabb, engineers and founders here. As it must prove of immense advantage in some departments of founding, and as Messrs. B. and McN. have no intention of taking out a patent, we shall, in order to secure to them the honour of the invention, and to the trade generally the benefit, state briefly how the operation is performed. The casting operated on, was one of the large circular plates, on which the New Draw-bridge at Inchinnan is to revolve. It is nineteen feet in diameter, besides some projecting horns to secure it in the masonry; the weight is about nine tons. To secure such a mass casting on a spindle, and to set it in motion, would be attended with much trouble, and considerable danger and risk; besides, the yielding of so large a circle when the cutting tool was made to bear on it, would have to be provided against, in a way that would increase friction. To obviate this and other inconveniences, motion is given to the cutting tool instead of the casting itself. The casting is first laid on the solid ground and brought to, and secured on a true level; a perpendicular revolving shaft is then erected in the centre, and motion communicated to it from the engine by shafts and bevelled wheels. On one of the arms of this centre shaft the cutting tool is placed in a way that admits of its being shifted outwards and inwards to answer the different parts of the ring, and it is secured by means which will readily suggest themselves to practical men, so as to preserve a steady horizontal motion, without dipping to form hollow places, or rising to leave protuberances. The advantages which this method possesses over the old one, are about as great as those obtained by setting the spit in motion, instead of causing the fire-grate to revolve for the purpose of roasting a leg of mutton.—*Paisley Advertiser.*

METEOROLOGY.—According to the observations of M. Peltier, the greater part of the clouds of last year were electrical, and almost all of these positively so. This year almost all the clouds are neutral, and those few which are electric have the negative fluid. M. Peltier earnestly invites those who possess the opportunity, to extend observations of this nature in mountainous countries.

CIRCULATION OF BANK NOTES.

AN ACCOUNT OF THE AGGREGATE AMOUNT OF NOTES CIRCULATED IN ENGLAND AND WALES BY PRIVATE BANKS, AND BY JOINT STOCK BANKS AND THEIR BRANCHES; DISTINGUISHING PRIVATE FROM JOINT STOCK BANKS.

(From Returns directed by 3 and 4 William IV., cap. 83.)

Quarters ending	Private Banks.	Joint Stock Banks.	Total.
28 Dec. 1833	8,836,803	1,315,301	10,152,104
29 March, 1834	8,733,400	1,458,427	10,191,827
28 June, —	8,875,795	1,642,887	10,518,682
27 Sept. —	8,370,423	1,783,689	10,154,112
28 Dec. —	8,537,655	2,122,173	10,659,828
28 March, 1835	8,231,206	2,188,954	10,420,160
27 June, —	8,455,114	2,484,687	10,939,801
26 Sept. —	7,912,587	2,508,036	10,420,623
26 Dec. —	8,334,863	2,799,551	11,134,414
26 March, 1836	8,353,894	3,094,025	11,447,919
25 June, —	8,614,132	3,588,064	12,202,196

Stamps and Taxes, Aug. 2.

JOHN WOOD.

BANK OF ENGLAND.

	Circulation.	Deposits.	Bullion.	Securities.
28 Dec. 1833 ..	17,469,000	15,169,000	10,200,000	24,576,000
29 March, 1834 ..	18,544,000	13,750,000	8,753,000	25,787,000
28 June, — ..	18,689,000	15,373,000	8,885,000	27,471,000
27 Sept. — ..	18,437,000	12,790,000	6,917,000	26,915,000
28 Dec. — ..	17,070,000	13,019,000	6,978,000	25,551,000
28 March, 1835 ..	18,152,000	9,972,000	6,295,000	24,533,000
27 June, — ..	17,637,000	11,753,000	6,613,000	25,221,000
26 Sept. — ..	17,320,000	13,866,000	6,284,000	27,724,000
26 Dec. — ..	16,564,000	20,370,000	7,718,000	31,764,000
26 March, 1836 ..	17,669,000	12,875,000	8,014,000	25,521,000
25 June, — ..	17,184,000	15,730,000	6,868,000	28,847,000

DISCOVERY OF RARE COINS AND RELICS.—In making some underground improvements and cellage, beneath the premises lately occupied by Mr. Pillin, grocer, Butter-cross, in this town, during the past and present week, several Roman silver and copper coins have been discovered, also fragments of Roman urns, pitchers, pots, &c., some of which bear inscriptions of a very ancient date. We have been favoured with a sight of two of the coins, and some of the fragments alluded to, which are now in the possession of Mr. Ravenhill, jun., Baxtergate—the silver coin is one of the Cæsars; but that of copper is almost as perfect as when struck, and bears the following inscription:—"SEVERVS. AVG. PART. MXX." being one of the Emperor Severus, who died at York, about 1700 years ago, and from its perfect state is a rich addition to the cabinet of the antiquarian. Besides the above, a vast number of the bones of various animals have been dug up, and as further improvements are making for Mrs. Kidson, the owner of the premises, we may expect other discoveries.—*Doncaster Courier.*

RAILWAY PERFORMANCE EXTRAORDINARY.—The locomotive steam-engine, *George Washington*, made for the State of Pennsylvania, by William Norris, of Philadelphia, was placed on the Columbia and Philadelphia railroad on Saturday afternoon, the 9th of July. On the following morning her powers were tested, in ascending the inclined plane near Philadelphia. This plane is 2800 feet in length, with an ascent, in that distance, of 196 feet, being at the rate of 369 feet the mile, or seven feet rise in 100 feet, or one foot in thirteen. The weight of the engine is 14,930lbs. only. The load attached weighed 19,200lbs., including the weight of twenty-four persons, who were on the tender and burden car. The engine started immediately at the base, without a running start, and dragged up the said load of 19,200lbs., the above distance of 2800 feet, in the space of two minutes and one second, or at the rate of 14½ miles per hour; pressure on the boiler, a fraction under 60lbs. to the square inch. The engine then descended the plane with the same load, at various speeds, frequently stopping to test the security. The valves being reversed, or set for going a-head, and when it was desired to stop altogether, the steam was let on very slowly, which brought her to a dead stand for a second or two, when she would immediately start up the grade. In this way, stopping and starting at pleasure, the time occupied in descending the 2800 feet, was from twelve to fifteen minutes, thus testing the perfect security of her performance on the plane. She again ascended the plane, with the same load, and took her place on the road the same morning, ready for use.—*American Railroad Journal.*

SAFETY STEAM BOILERS.—It is pretty generally known that Mr. Galy-Cazalet has contrived a method of preventing the fatal effects of explosion by steam-boilers, which he has patented. His plan consists in having a tube perforating the boiler, from a little above the top to the bottom, or a little below, which is in communication with the upper, or steam part of the boiler. Through a stop-cock at the top, a mixed metal bullet is let fall into a socket near the bottom of the tube, which it fits steam-tight. While the temperature of the steam is beneath a certain point, the bullet remains, but as soon as this is surpassed the bullet melts, and the steam rushes into the fire, and quickly puts it out, or arrests its vigour. By this means the pressure in the boiler is limited to a certain extent, and the breach is instantly repaired by undoing the stop-cock, and dropping another bullet into the socket. We have not heard whether this invention has been used; the whole efficacy of it turns on the certainty of the bullet melting at a given temperature.—*Railway Magazine.*

ROTARY ENGINES.—It would appear, by accounts from America, that Mr. Avery is exciting as much interest with his rotary engine, as Lord Dundonald, some time since, did with his. Mr. Avery, however, is proceeding in the safe path of practical application, and seems to be creating almost as great a sensation in Europe as he has in America. We have long been convinced that a good rotary engine is now the grand desideratum for locomotive carriages.—*Railway Magazine.*

GAS IN COAL.—Several circumstances induced Mr. Hutton, while engaged in his microscopic inquiries into the organic structure of fossils, to search for a structure in coal capable of containing gas. Accordingly, he discovered a system of cells differing from those containing bituminous matter. The anthracite coal of South Wales contains the gas cells, but is free from the latter. He also states, on the authority of Mr. Foster, that the anthracite coal of South Wales affords a free disengagement of inflammable gas when first exposed to the air.

SUB-MARINE EXCURSION.—On Monday week, Mr. Joseph Orchard, made a sub-marine excursion in Weymouth Bay, in the presence of a great concourse of spectators. He submerged at the New Pier Head, and walked at the bottom of the water round the bay; in his journey he picked up several articles, amongst others an antique pewter tankard, which, from its corroded state, must have been long under water. The diver was accompanied by a boat, with an air-pump, from which he received a constant supply.

STEAM VESSEL WITH A MERCURIAL BOILER.—A vessel, called the *Vesta*, has been plying between London and Margate, worked on the principle of Howard's vapour engine; that is, instead of a boiler, by throwing the water to be converted into steam on an iron plate, covering a quantity of mercury, kept at a high temperature. It is said she works well, and is able to cope with the most powerful steamers on the river. If this plan succeeds, it is expected two-thirds of the fuel will be saved.—*Railway Magazine.*

MACHINERY.—With the consumption of one bushel of coals, which costs three pence, a steam-engine raises as much water as could possibly be raised by human labour for fifty shillings. If the coals employed in England in the various operations of manufactures and commerce were replaced by human hands, the whole agricultural population would be required to execute the same quantity of work. But the profits of their labour would not nearly suffice for their subsistence; not even were coals twenty times as dear as they now are: the inevitable effects of which would be to annihilate all those manufactures which depend upon cheap fuel.

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